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EXAMINER

TOLEDO, FERNANDO L

ART UNIT PAPER NUMBER

2823

DATE MAILED: 05/16/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/817 154

Examiner

Fernando Toledo

Applicant(s)

KIRITANI NORIHIKO

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☐ Responsive to communication(s) filed on 24 February 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☐ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 19 and 20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) 5, 9 and 11 is/are allowed.
- 6) ☐ Claim(s) 1-4, 6-8 and 12-18 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on 27 March 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All b) ☐ Some \* c) ☐ None of:  
1. ☒ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_ 6) ☐ Other \_\_\_\_\_

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1 – 4 and 6 – 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tyagi et al. ("An Isoplanar Isolation Technology for SiC Devices Using Local Oxidation" pages 2188 – 2191) in view of Ueno et al. (U. S. patent 6,265,326 B1).

In re claim 1, Tyagi in the article "An Isoplanar Isolation Technology for SiC Devices Using Local Oxidation" teaches depositing a silicon film over a SiC substrate; delineating the silicon film into a required pattern so as to expose a surface of the SiC substrate; and annealing the SiC substrate to selectively grow a localized thermal film above the SiC substrate (pages 2188 – 2191).

Tyagi does not teach annealing the SiC substrate in a water rich ambient.

However, Ueno in the U. S. patent U. S. patent 6,265,326 B1; figures 1 – 4 and related text, discloses thermally growing an oxide layer in a water rich environment to increase the speed of formation of a thermal oxide (abstract).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to anneal the SiC substrate of Tyagi in water rich vapor, as taught by Ueno, since it would increase the speed of formation of a thermal oxide.

3. In re claim 2, Tyagi in view of Ueno discloses wherein  $H_2O$  partial pressure in the water rich ambient is selected such that oxidation rate for the silicon film is larger than that for SiC substrate (abstract).

4. In re claim 3, Tyagi in view of Ueno discloses wherein the  $H_2O$  partial pressure in water rich ambient is kept more than 0.95 (figure 4).

5. In re claim 4, Tyagi discloses wherein the silicon film is delineated into a pattern for an element isolation region (figure 4).

6. In re claim 6, Tyagi discloses forming a blanket silicon oxide film at a surface of the SiC substrate in an oxygen added ambient, before depositing the silicon film so that the silicon film can deposit on the blanket silicon oxide film (figure 4).

7. In re claim 7, Tyagi in view of Ueno discloses wherein the  $H_2O$  partial pressure in the oxygen added ambient is kept less than 0.95 (figure 4).

8. In re claim 8, Tyagi discloses selectively removing the blanket silicon oxide film using the silicon film as an etching mask so as to expose a part of the surface of the SiC substrate, before the silicon film is selectively oxidized in the water rich ambient (figure 4).

9. In re claim 10, Tyagi in view of Ueno does not disclose wherein the water is ultra pure water.

However, It would have been obvious to one having ordinary skill in the art at the time the invention was made to use ultra pure water in the invention of Tyagi Ueno since ultra pure water does not carry any type of impurities that could adversely affect the electrical and chemical properties of the device that could later diminish the effectiveness of the device.

10. Claims 13 – 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Palmour (U. S. patent 5,459,107) in view of Ueno.

In re claims 13 and 18, Palmour in the U. S. patent 5,459,107; figures 1A – 4C and related text discloses forming a gate oxide film on a surface of a SiC substrate; and annealing the gate oxide film.

Palmour does not show wherein the annealing takes place in a water rich environment at a temperature equal to or lower than the substrate temperature at which the gate oxide film is formed and that that temperature is of about 700°C – 1050°C.

Ueno discloses that to increase the rate of speed of formation of a thermal oxide film of a silicon carbide semiconductor device, the partial pressure of water is controlled within a range of 0.1 to 0.95 (abstract) at a temperature of about 1000°C (column 3).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to anneal in a water rich environment at a temperature equal to or lower than the substrate temperature at which the gate oxide film is formed and that that temperature is of about 700°C – 1050°C in the invention of Palmour, since as taught by Ueno to increase the rate of speed of formation of a thermal oxide film of a silicon

carbide semiconductor device, the partial pressure of water is controlled within a range of 0.1 to 0.95 at a temperature of about 1000°C.

Palmour in view of Ueno does not disclose so as to reduce interface density between the gate oxide and the SiC substrate.

The recited results would be obtained because the same materials are treated in the same manner as in the instant invention.

11. In re claim 14, Palmour in view of Ueno teaches wherein the partial pressure of H<sub>2</sub>O in the water rich ambient is kept more than 0.95 (figure 4).

12. In re claim 15, Palmour discloses wherein forming the gate oxide film includes oxidizing the surface of the SiC substrate in an oxygen added ambient (column 2).

13. In re claim 16, Palmour and Ueno teaches wherein H<sub>2</sub>O partial pressure in the oxygen added ambient is kept less than 0.95 (figure 4).

14. In re claim 17, Palmour discloses wherein forming the gate oxide film includes: depositing a silicon film 13 at the surface of the SiC substrate; annealing the SiC substrate to grow the gate oxide film at the surface of the SiC substrate (figure 3B).

Palmour does not disclose annealing in a water rich environment.

Ueno discloses that to increase the rate of speed of formation of a thermal oxide film of a silicon carbide semiconductor device, the partial pressure of water is controlled within a range of 0.1 to 0.95 (abstract).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to anneal in a water rich environment in the invention of Palmour, since as taught by Ueno to increase the rate of speed of formation of a thermal oxide

film of a silicon carbide semiconductor device, the partial pressure of water is controlled within a range of 0.1 to 0.95.

***Allowable Subject Matter***

15. Claims 5, 9 and 11 are allowable over the prior art of record.

16. The following is a statement of reasons for the indication of allowable subject matter:

17. In re claim 5, Tyagi in view of Ueno substantially discloses the claimed invention. However, Tyagi in view of Ueno does not disclose, teach or suggest forming a trench at the surface of the SiC substrate before depositing the silicon film, wherein the silicon film is delineated such that the silicon film buries the trench, and the silicon film buried in the trench is selectively oxidized in the water reach ambient.

The invention of Tyagi pertains to a LOCOS process with a SiC substrate while Ueno pertains to forming thermal oxidation films of SiC semiconductor devices. It would be impermissible hindsight to suggest that the invention pertaining to claim 5 would be obvious since none of them teach even forming a trench on the substrate, let alone, filling it with polysilicon.

18. In re claim 9, Tyagi in view of Ueno substantially discloses the claimed invention. However, Tyagi in view of Ueno does not teach forming a thin silicon oxide film at the exposed part of the surface of the SiC substrate in the oxygen added ambient after selectively growing the localized thermal oxide film, wherein the oxygen added ambient

and the water rich ambient are successively achieved in a same reaction tube so as not to expose the surface of the SiC substrate to an air outside of the reaction tube.

Neither Tyagi nor Ueno gives motivation to form an additional thin silicon oxide film after the formation of the localized thermal oxide film. It would take improper hindsight to assume that either reference alone or in combination would form the thin oxide film.

19. In re claim 11, Tyagi in view of Ueno does not show, teach or suggest forming a gate oxide film at the exposed part of the surface of the SiC substrate in the oxygen added ambient and annealing it in a rich water ambient at a substrate temperature lower than the substrate temperature at which the gate oxide is formed.

Tyagi shows forming FOX regions while covering the area where the gate oxide would be formed. It would take improper hindsight to assume that either reference alone or in combination would form a gate oxide and annealing it in a rich water ambient at a substrate temperature lower than the substrate temperature at which the gate oxide is formed.

### ***Response to Arguments***

20. Applicant's arguments filed 24 February 2003 have been fully considered but they are not persuasive for the following reasons.

Applicant contests that Tyagi does not disclose or suggest the claimed step of delineating the silicon film into a required pattern so as to expose a surface of the SiC substrate.



Examiner respectfully submits that Figure 4(a) of Tyagi shows the SiC substrate being exposed due to the delineation of the silicon film on top.

Examiner respectfully submits that Ueno discloses heating a thermal oxide (a gate oxide is a thermal oxide) at a temperature of about 1000°C since it will help form a better oxide.

Applicant's arguments have not overcome the rejection.

### ***Conclusion***

21. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).


A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fernando Toledo whose telephone number is 703-305-0567. The examiner can normally be reached on Mon-Fri 8am to 4pm.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7382 for regular communications and 703-308-7382 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

  
George Fourson  
Primary Examiner  
Art Unit 2823

  
FToledo  
May 15, 2003